CHAPTER 6

STABILIZATION WITH BITUMEN

6-1. Types of bituminous-stabilized soils.

a. Sand bitumen. A mixture of sand and bitumen in which the sand particles are cemented together to provide a material of increased stability.

b. Gravel or crushed aggregate bitumen. A mixture of bitumen and a well-graded gravel or crushed aggregate that, after compaction, provides a highly stable waterproof mass of subbase or base course quality.

c. Bitumen lime. A mixture of soil, lime, and bitumen that, after compaction, may exhibit the characteristics of any of the bitumen-treated materials indicated above. Lime is used with materials that have a high PI, i.e., above 10.

6-2. Soil gradation. The recommended soil gradations for subgrade materials and base or subbase course materials are shown in tables 6-1 and 6-2, respectively.

Table 6-1. Recommended Gradations for Bituminous-Stabilized Subgrade Materials

Sieve Size	Percent Passing
3 inch	100
No. 4	50-100
No. 30	38-100
No. 200	2-30

6-3. Types of bitumen. Bituminous stabilization is generally accomplished using asphalt cement, cutback asphalt, or asphalt emulsions. The type of bitumen to be used depends upon the type of soil to be stabilized, methods of construction, and weather conditions. In frost areas, the use of tar as a binder should be avoided because of its high-temperature susceptibility; however, material availability may require the use of tars in nonfrost areas. Asphalts are affected to a lesser extent by temperature changes, but a grade of asphalt suitable to the prevailing climate should be selected. As a general rule, the most satisfactory results are obtained when the most viscous liquid asphalt that can be readily mixed into the soil is used. For higher quality mixes in which a central plant is used, viscosity-grade asphalt cements should be used. Much bituminous stabilization is performed in place with the bitumen being applied directly on the soil or soil-aggregate system and the mixing and compaction operations being conducted immediately thereafter. For this type of construction,

Table 6-2. Recommended Gradations for Bituminous-Stabilized Base and Subbase Materials

Sieve Size	1-1/2-inch Maximum	1-inch Maximum	3/4-inch Maximum	1/2-inch Maximum
1-1/2-inch	100	--	--	--
1-inch	84 ± 9	100	--	--
3/4-inch	76 ± 9	83 ± 9	100	--
1/2-inch	66 ± 9	73 ± 9	82 ± 9	100
3/8-inch	59 ± 9	64 ± 9	72 ± 9	83 ± 9
No. 4	45 ± 9	48 ± 9	54 ± 9	62 ± 9
No. 8	35 ± 9	37 ± 9	41 ± 9	47 ± 9
No. 16	27 ± 9	28 ± 9	32 ± 9	36 ± 9
No. 30	20 ± 9	21 ± 9	24 ± 9	28 ± 9
No. 50	14 ± 7	16 ± 7	17 ± 7	20 ± 7
No. 100	9 ± 5	11 ± 5	12 ± 5	14 ± 5
No. 200	5 ± 2	5 ± 2	5 ± 2	5 ± 2

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liquid asphalts, i.e., cutbacks and emulsions, are used. Emulsions are preferred over cutbacks because of energy constraints and pollution control efforts. The specific type and grade of bitumen will depend on the characteristics of the aggregate, the type of construction equipment, and climatic conditions. Generally, the following types of bituminous materials will be used for the soil gradation indicated:

a. Open-graded aggregate.

(1) Rapid- and medium-curing liquid asphalts RC- and MC-70, 250, and 800, and MC-3000.

(2) Medium-setting asphalt emulsion MS-2 and CMS-2.

(3) Tars RT-1 and RT-2.

b. Well-graded aggregate with little or no material passing the No. 200 sieve.

(1) Rapid- and medium-curing liquid asphalts RC-250, RC-800, MC-250, and MC-800.

(2) Slow-curing liquid asphalts SC-250 and SC-800.

(3) Medium-setting and slow-setting asphalt emulsions MS-2, CMS-2, SS-1, and CSS-1.

(4) Tars RT-1, RT-2, RT-3, and RT-4.

c. Aggregate with a considerable percentage of fine aggregate and material passing the No. 200 sieve.

(1) Medium-curing liquid asphalts MC-250 and MC-800.

(2) Slow-curing liquid asphalts SC-250 and SC-800.

(3) Slow-setting asphalt emulsions SS-1, SS-1h, CSS-1, and CSS-1h.

(4) Medium-setting asphalt emulsions MS-2 and CMS-2.

(5) Tars RT-3, RT-4, RT-5, and RT-6.

d. Unbound aggregate. The simplest type of bituminous stabilization is the application of liquid asphalt to the surface of an unbound aggregate road. For this type of operation, the slow- and medium-curing liquid asphalts SC-250, MC-70, and MC-250 are used. Tar types RT-5 and RT-6 may be used in nonfreezing climates.

6-4. Mix design. Guidance for the design of bituminous-stabilized base and subbase courses is contained in EM 1110-3-131 and EM 1110-3-141. For subgrade stabilization, the following equation may be used for estimating the preliminary quantity of cutback asphalt to be selected:

$$p = \frac{0.02(a) + 0.07(b) + 0.15(c) + 0.20(d)}{(100 - S)} \times 100$$

where:

p = percent cutback asphalt by weight of dry aggregate
a = percent of mineral aggregate retained on No. 50 sieve
b = percent of mineral aggregate passing No. 50 and retained on No. 100 sieve
c = percent of mineral aggregate passing No. 100 and retained on No. 200 sieve
d = percent of mineral aggregate passing No. 200 sieve
S = percent solvent

The preliminary quantity of emulsified asphalt to be used in stabilizing subgrades can be determined from table 6-3. The final design content of cutback or emulsified asphalt should be selected based upon the results of the Marshall Stability test procedure (MIL-STD-620). The minimum Marshall Stability recommended for subgrades is 500 pounds. If a soil does not show increased stability when reasonable amounts of bituminous materials are added, the gradation of the soil should be modified or another type of bituminous material should be used. Poorly graded materials may be improved by the addition of suitable fines containing considerable material passing the No. 200 sieve. The amount of bitumen required for a given soil increases with an increase in percentage of the finer sizes.

Table 6-3. Emulsified Asphalt Requirements

Percent Passing No. 200 Sieve	Pounds of Emulsified Asphalt per 100 Pounds of Dry Aggregate at Percent Passing No. 10 Sieve					
	50	60	70	80	90	100
0	6.0	6.3	6.5	6.7	7.0	7.2
2	6.3	6.5	6.7	7.0	7.2	7.5
4	6.5	6.7	7.0	7.2	7.5	7.7
6	6.7	7.0	7.2	7.5	7.7	7.9
8	7.0	7.2	7.5	7.7	7.9	8.2
10	7.2	7.5	7.7	7.9	8.2	8.4
12	7.5	7.7	7.9	8.2	8.4	8.6
14	7.2	7.5	7.7	7.9	8.2	8.4
16	7.0	7.2	7.5	7.7	7.9	8.2
18	6.7	7.0	7.2	7.5	7.7	7.9
20	6.5	6.7	7.0	7.2	7.5	7.7
22	6.3	6.5	6.7	7.0	7.2	7.5
24	6.0	6.3	6.5	6.7	7.0	7.2
25	6.2	6.4	6.6	6.9	7.1	7.3

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